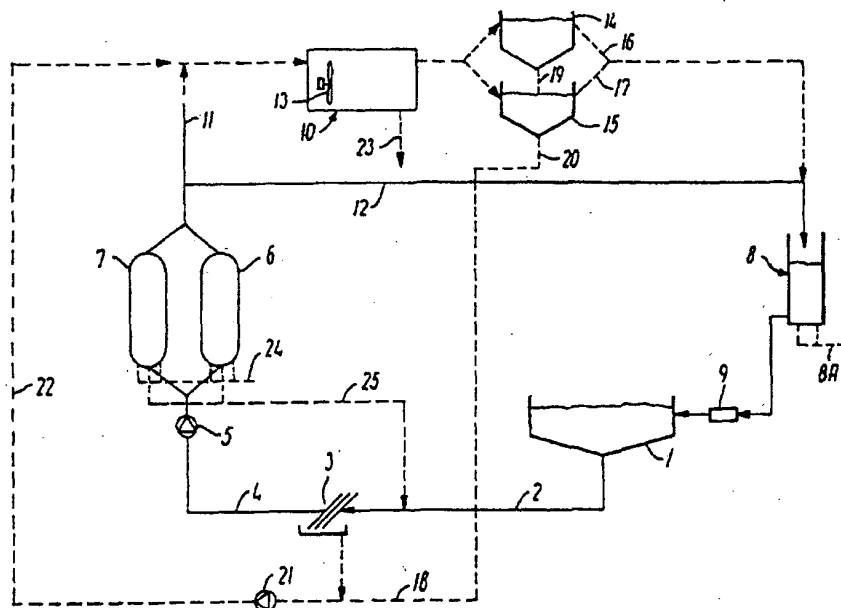




(51) International Patent Classification 6 : A01K 63/04, C02F 3/30	A1	(11) International Publication Number: WO 96/04784 (43) International Publication Date: 22 February 1996 (22.02.96)
<p>(21) International Application Number: PCT/DK95/00325</p> <p>(22) International Filing Date: 10 August 1995 (10.08.95)</p> <p>(30) Priority Data: 0935/94 12 August 1994 (12.08.94) DK</p> <p>(71) Applicant (for all designated States except US): MATCON, RÅDGIVENDE INGENIØRFIRMA A/S [DK/DK]; Generatørvej 45, DK-2730 Herlev (DK).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): FISCHER, Knud [DK/DK]; Venslevleddet 9, DK-4050 Skibby (DK). KONGERSLEV, Thomas, Ravn [DK/DK]; Vestre Paradisvej 99, DK-2840 Holte (DK). VILLADSEN, Andreas [DK/DK]; Øverødvej 54, DK-2840 Hulte (DK).</p> <p>(74) Agents: JØRGENSEN, Bjørn, Baker et al.; International Patent-Bureau, Høje Taastrup Boulevard 23, DK-2630 Taastrup (DK).</p>	<p>(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, US, UZ, VN. European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). ARIPO patent (KE, MW, SD, SZ, UG).</p> <p>Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments. In English translation (filed in Danish).</p>	

(54) Title: A SYSTEM AND A METHOD FOR AQUATIC PRODUCTION



(57) Abstract

The system comprises a growing tank (1) and recycling circuits for the water of the tank with a mechanical filter (3) for removal of particles from the water, a biofilter (6, 7) for nitrification of ammonia to nitrate, a device for oxygen supply (8), and a device (10, 14, 15) for denitrification of nitrate to free-nitrogen comprising a tank (10) with suspended active sludge followed by a device (14, 15) for mechanical separation of sludge and water.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

A SYSTEM AND A METHOD FOR AQUATIC PRODUCTION

The present invention relates to a system for aquatic production comprising a growing tank and recycling circuits for the water of the tank with a mechanical filter for removal of particles from the water, a biofilter for nitrification of ammonia into nitrate, and a device for denitrification of nitrate to free nitrogen, as well as a device for oxygen supply. A system of this type is known from JP-A-5 277 495, which discloses a system, in which the device for denitrification comprises a bed of filter sand with denitrifying bacteria at the bottom of a water tank, the water of which is circulated.

The invention further relates to a method for running a system for aquatic production with recycling, in which system water from a growing tank is circulated through a mechanical filter for removal of particles, a biofilter for nitrification of ammonia to nitrate, and oxygen is supplied to the water.

In systems for aquatic production, such as fish growth, the water in the growing tank or tanks is polluted by surplus fish feed, excrements and ammonia, which the fish excrete as a metabolic waste product. The ammonia is toxic for the fish and therefore has to be removed from the water, which in a common growing system with recirculation takes place by means of a biofilter, in which bacteria convert ammonia to nitrate in an aerobic process.

It is, however, necessary to remove the nitrate created in the biofilter from the water in order not to get an accumulation thereof in the water, and in conventional systems this nitrate is currently removed by changing part of the water.

As the process in a biological filter is oxygen consuming, the water is normally subjected to aeration before it is taken back to the growing tank, just as the water usually is disinfected by means of UV- rays and/or addition of ozone to part of the recycled water.

The exchange of water in order to get rid of the nitrate and other waste products is a substantial problem when running a growing system, partly because the accumulated waste products constitute a threat to the environment, partly because a huge amount of water is required.

The object of the invention is to provide a system and a method for aquatic production, according to which it substantially is not necessary to exchange the growing water, and where the environmental impact is minimal.

This object is met by means of a system of the type mentioned by way of introduction, said method being characteristic in that the device for denitrification comprises a tank with suspended active sludge followed by mechanical equipment for separating water and sludge.

The object is further met by means of a method of the type mentioned above, which is characteristic in that the water is further circulated through a tank with suspended active sludge for denitrification of nitrate to free nitrogen and subsequently through a device for mechanical separation of sludge and water.

In a preferred embodiment of the method according to the invention the material filtered off in the mechanical filter is led to the tank with suspended active sludge. Hereby is obtained that the filtered off material which in conventional growing systems has to be disposed of and consequently affects the environment, serves as nutrient for the denitrification process, for which reason the need for disposal of separated material is considerably reduced.

In a further embodiment the water is led to the tank with suspended active sludge from the biological filter, whereby is obtained that the water which is led to the tank with suspended active sludge is substantially free from oxygen.

The invention may be used in connection with water with a salt concentration corresponding to that of fresh water, brackish water or sea water, i.e. 0-3.6% and even up

to 5.5%.

It has surprisingly turned out to be possible to use suspended active sludge for the denitrification and subsequently to precipitate the sludge to such an extent that fish may subsequently thrive in the water. By using suspended active sludge for the denitrification it becomes possible to carry on this process continuously, as there is no solid filter mass to be cleaned or regenerated from time to time.

The invention will be described in detail in the following by means of embodiments with reference to the drawing, in which

Fig. 1 schematically shows a system for fish growth with a recirculation circuit, and

Fig. 2 a second system with a second recirculation circuit.

Fig. 1 thus shows a growing system comprising a conventional system, the components of which are connected with pipes, which are shown with fully drawn lines, and an extension according to the invention, which is connected with the conventional part by means of pipes shown as broken lines.

The conventional part comprises one (or more) growing tanks 1, a mechanical filter 3, a biofilter, here in the shape of two parallelly disposed filters 6, 7, an oxygen supply device 8 with air supply 8A and a possible disinfection device 9. The growing tank 1, the mechanical filter 3, the biofilters 6, 7 and the oxygen supply device 8 are connected by means of pipes 2, 4, and 12, the pipe 4 comprising a pump sump for a circulation pump 5.

As something new the system comprises an anoxic tank 10, to which a variable partial current may be led from the biological filters 6, 7 through a pipe 11 instead of being led directly through the pipe 12 to the oxygen supply device 8. The anoxic tank 10 contains suspended active sludge which is kept in suspension by means of a stirrer 13. From the anoxic tank 10 pipes lead to two parallelly

driven settling tanks 14, 15, from which overflows 16, 17 lead back to the main stream from the biofilters 6, 7 and to the oxygen supply device 8.

Moreover, a common container 18, which in the drawing is just shown as a pipe, is provided. Sedimentary sludge is led to this common container 18 from the sedimentation tanks 14, 15 through pipes 19, 20, and to the common container 18 also rinsing water from rinsing of the mechanical filter 3 is led. Water, sludge and material filtered off by the mechanical filter 3 are by means of a pump 21 pumped to the anoxic tank 10 through a pipe 22.

During operation water is recycled from the growing tank 1 through the pipe 2 to the mechanical filter 3 and further on to the pump sump 4. The mechanical filter is to be rinsed now and again, and the cleansing water is taken from the pump sump 4 and led together with the material filtered off to the drainage tank 18.

By means of the circulation pump 5 the filtered water is pumped through the biofilters 6, 7 and therefrom the main flow is led through the pipe 12 to the oxygen supply device 8. A variable partial current is led to the anoxic tank 10 which contains suspended active sludge, in which a denitrification takes place, nitrate (NO_3) being transformed into free nitrogen (N_2). A prerequisite for the success of this process is that free oxygen is substantially not present in the anoxic tank. In some cases it has turned out that the amount of organic material, which is supplied from the filter 3 in form of filtered off feed remnants and excrements, etc. is not sufficient for ensuring complete exhaust of the oxygen present. Therefore, additional organic material, for instance sugar, is added, partly to reduce the oxygen contents, partly to establish the carbon source necessary for nourishing the denitrification process.

Water with part of the sludge is led from the anoxic tank to the settling tanks 14, 15, in which the sludge is deposited and brought through the pipes 19, 20 to the

common tank 18, from where it is pumped back to the anoxic tank 10. The defecated water is led through the overflow pipes 16, 17 back to the main flow and to the aeration container 8. During the process in the anoxic tank 10 a
5 sludge is created, for which reason excess sludge is removed through the bottom of the tank 10 as shown by the arrow 23 and removed from the system.

The suspended sludge in the anoxic tank 10 has in the example described been produced by means of microorganisms
10 from the environment, which during the operation of the system has formed a colony in the tank 10, as the right conditions prevailed, i.e. nitrate and organic carbon were present, but on the whole no free oxygen.

The biofilters 6, 7 do in the example contain a
15 matrix of a plastics material, on the surface of which nitrifying bacteria deposit during the operation of the system. These are for instance Nitrosomonas and Nitrobakter. A nitrification takes place in the biological filters 6, 7, ammonia being converted into nitrate. This
20 process is pH-dependent and a pH above 8 is therefore aimed at.

This is in conventional systems made by means of a necessary addition of calcium carbonate (CaCO_3). This addition of calcium carbonate has surprisingly turned out
25 to be superfluous in the system described, because the denitrifying process apparently establishes an alkalinity which corresponds to the one consumed by the nitrifying process.

The biofilters 6, 7 are cleaned like in conventional
30 systems from time to time (for instance by blowing in air 24), and the separated sludge is led through a pipe 25 to the mechanical filter 3 to end up in the anoxic tank 10, where it takes part in the current process.

Apart from the operation described above with fresh
35 water, the inventors have performed sea water operation. In the sea water operation for instance a salt concentration of 3.6% is used and a starting culture is introduced in the

system, said culture comprising a mixture of salt-tolerant, nitrifying and denitrifying bacteria. The system has turned out surprisingly to function satisfactorily with sea water operation without a feared development of H_2S , which is very toxic to fish.

Fig. 2 shows in a schematic diagram a modification of the system according to Fig. 1. In the system shown in Fig. 2 all the water, which through the anoxic tank 10 is recycled from the growing tank 1, is cleansing water from cleaning of the mechanical filter 3. Furthermore, a pipe 26 with a pump 27 has been introduced between the pump sump 4 and the pipe 12 in such a way that it is possible to lead only part of the water filtered off in the mechanical filter 3 through the biofilters 6, 7.

Two different circuit configurations have been shown and described, but it is to be understood that several others are possible.

C L A I M S

1. A system for aquatic production comprising a growing tank (1) and recycling circuits for the water of the tank with a mechanical filter (3) for removal of particles from the water, a biofilter (6, 7) for nitrification of ammonia into nitrate, and a device (10, 14, 15) for denitrification of nitrate to free nitrogen, as well as a device for oxygen supply,
c h a r a c t e r i z e d in that the device for denitrification comprises a tank (10) with suspended active sludge followed by a device (14, 15) for mechanical separation of sludge and water.
2. A system according to claim 1,
c h a r a c t e r i z e d in that the device (10, 14, 15) for denitrification is connected with the biological filter (6, 7) in series after the biological filter.
3. A method of running a system for aquatic production with recycling, in which system water from a growing tank (1) is circulated through a mechanical filter (3) for removal of particles, a biological filter (6, 7) for nitrification of ammonia to nitrate, and oxygen is supplied to the water,
c h a r a c t e r i z e d in that the water is further circulated through a tank (10) with suspended active sludge for denitrification of nitrate to free nitrogen and subsequently through a device for mechanical separation of sludge and water.
4. A method according to claim 3,
c h a r a c t e r i z e d in that the material filtered off in the mechanical filter is led to the tank (10) with suspended active sludge.
5. A method according to claims 3 and 4,
c h a r a c t e r i z e d in that the sludge separated in the device (14, 15) for separating sludge and water is returned to the tank (10) with suspended active sludge.
6. A method according to claims 3-5,

c h a r a c t e r i z e d in that the water is led to the tank (10) with suspended active sludge from the biological filter (6, 7).

7. A method according to claims 3-6,
5 c h a r a c t e r i z e d in that carbonaceous, organic material, for instance sugar, is added to the tank (10) with suspended active sludge.

8. A method according to claims 3-7,
c h a r a c t e r i z e d in that the water has a salt
10 concentration (Nail) of 0-5.5%, preferably 0-3.6%.

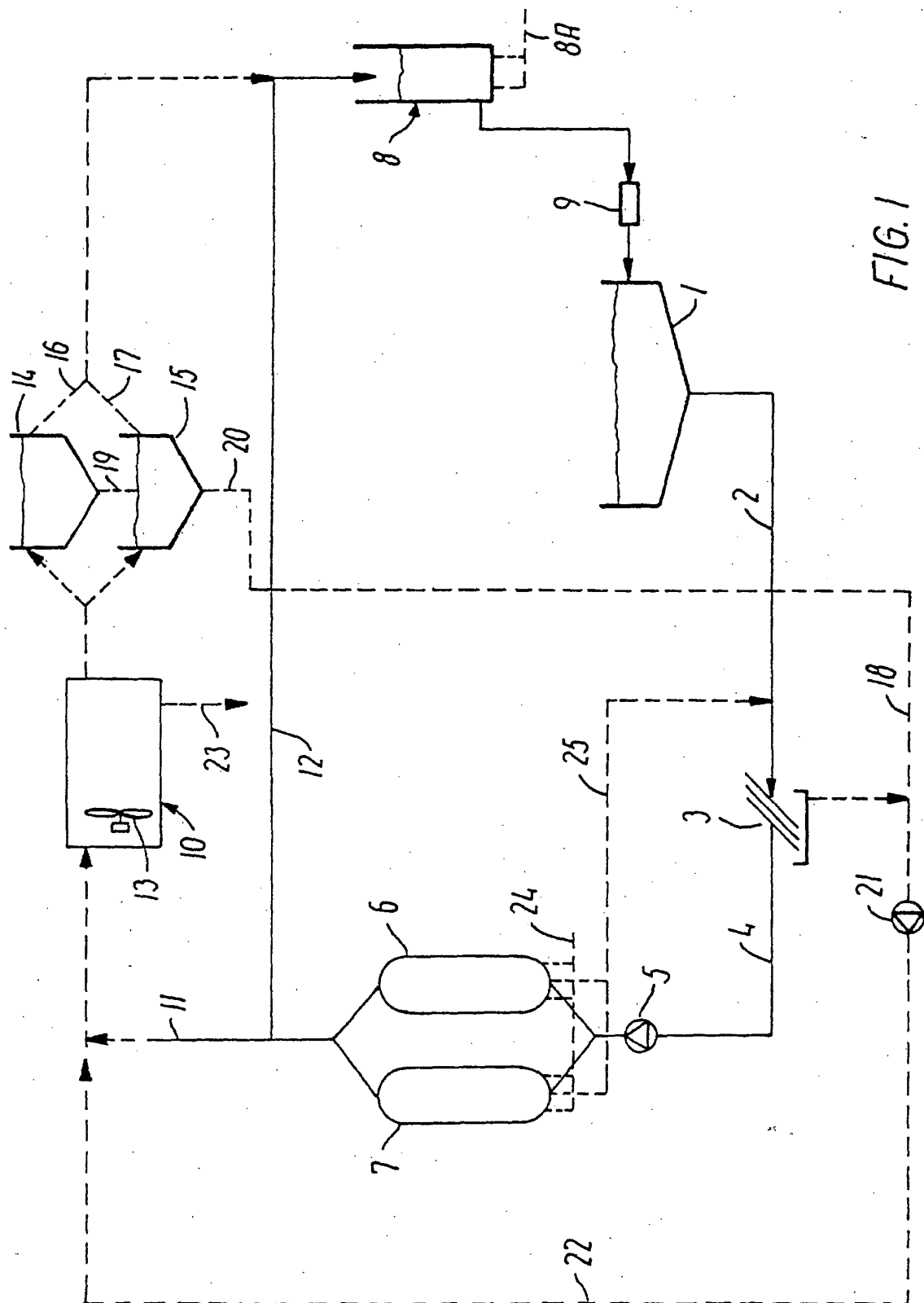


FIG. 1

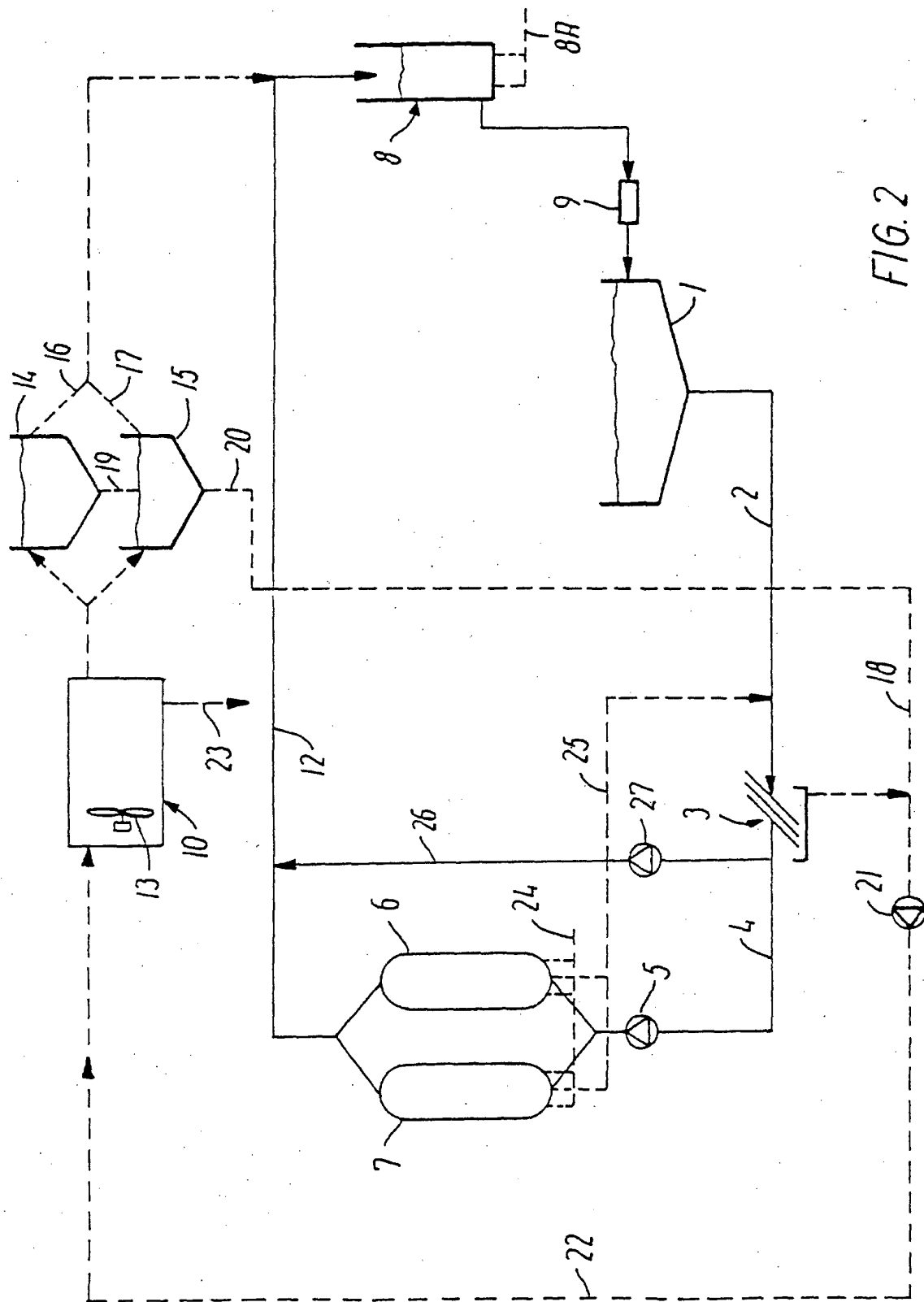


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 95/00325

A. CLASSIFICATION OF SUBJECT MATTER		
IPC6: A01K 63/04, C02F 3/30 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC6: A01K, C02F		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 2441788 A1 (BATTELLE-INSTITUT E.V.), 18 March 1976 (18.03.76)	1-7
X	--	3,8
Y	US 3849303 A (WILBUR N. TORPEY), 19 November 1974 (19.11.74), claims 1,4	1-6
Y	US 3846289 A (J.S. JERIS ET AL), 5 November 1974 (05.11.74), claim 2	7
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
12 December 1995		13.12.95
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer Bo Bergström Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 95/00325

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PROG.WAT.TECH., Volume 8, No 4/5, 1977, Harold A. Nicholls, "Modification of extended aeration plants in Johannesburg, South Africa, to achieve denitrification", page 639 - page 652, figure 1 --	1-3
A	US 3953327 A (DENNY S. PARKER), 27 April 1976 (27.04.76) -- -----	1-7

INTERNATIONAL SEARCH REPORT
Information on patent family members

30/10/95

International application No.

PCT/DK 95/00325

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A1- 2441788	18/03/76	NONE	
US-A- 3849303	19/11/74	CA-A- 998481 CH-A- 594569 DE-A- 2349029 FR-A,B- 2201259 GB-A- 1418584 JP-A- 49094158 US-A- 3817857 US-A- 3869380	12/10/76 13/01/78 04/04/74 26/04/74 24/12/75 06/09/74 18/06/74 04/03/75
US-A- 3846289	05/11/74	BE-A,A- 801127 CA-A- 986239 CH-A- 572870 DE-A,B,B 2331192 DE-A- 2366033 FR-A,B- 2189328 GB-A- 1430410 JP-A- 54099348 NL-A- 7308423 US-A- 3956129	19/12/73 23/03/76 27/02/76 10/01/74 14/07/77 25/01/74 31/03/76 06/08/79 21/12/73 11/05/76
US-A- 3953327	27/04/76	JP-A- 50069851	10/06/75

